ElectroMagnetic Radiation In Your Home

When you settle down for your long winter's nap, you may be getting far more electrical stimulation than you ever dreamt.

Our willingness to go to bed with electromagnetic technology in one or other of its household guises, is now being blamed for miscarriages, possible birth defects, slower foetal development and even some forms of cancer.

Before you become more alarmed than your alarm clock, let us first try to get a bit clearer about just what the problem is.

By Prof Ron S. Laura & John F. Ashton

Extracted from their recent book:
Hidden Hazards
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THE ELECTRIC BLANKET/HEATED WATER BED CONNECTION: SHOULD YOU BE PLUGGED IN?

Early Warning Signals

Smitten by the marvels of electrical power, we have as a society been slow either to notice or to investigate its harmful effects on the human body. One of the first published epidemiological studies on electrical power frequency fields was carried out by Dr Nancy Wertheimer and Ed Leeper of the University of Colorado.[1] Wertheimer was concerned in this initial study to determine whether a connection existed between exposure to electrical currents generated by high voltage power lines and the increased risk of childhood leukemia. Upon reflection it is perhaps not surprising that emanations from power lines with voltages as high as 230,000 volts (230 kilovolts) might be regarded as hazardous to health, even at some distance from the lines themselves.[2] The capacity of power lines to generate significant electrical fields at quite some distance from the line-wire source is amply illustrated in that well-known photograph of a young boy beneath a high voltage power line, holding a pair of fluorescent lamp tubes which were lit simply because he was standing in the electrical field generated by the line.

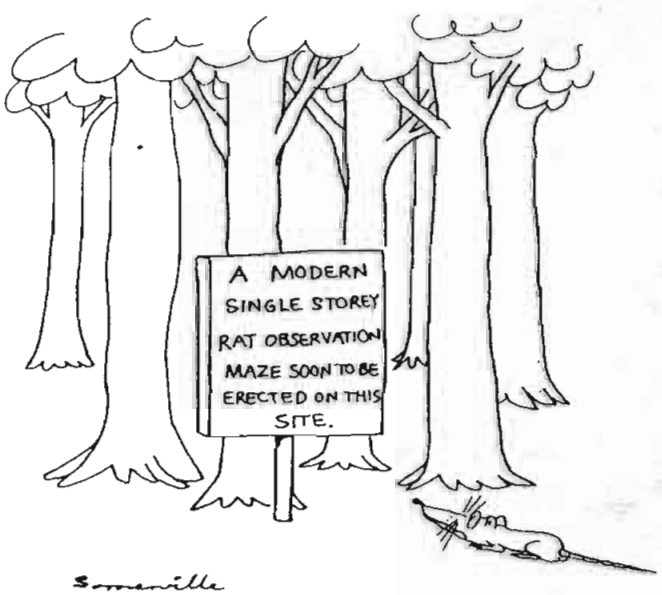
Initial research indicated that there was indeed a vague correlation between the location of high voltage power lines and the proximity of the homes of childhood leukemia victims, but considerable research had still to be undertaken until a more definitive pattern was to emerge.

Although the potential effect on human health of the high voltage power lines would continue to prove worrying, Wertheimer quickly became aware that the high voltages emanating from power generating plants and transported through major power lines are soon stepped down to 13,000 volts (13 kV) by large transformers set up at strategic points at a prescribed distance from the high voltage lines. Mapping the locations of the substations and the birth addresses of childhood leukemia victims, the pieces of the puzzle began to come together. In order to make electricity in the 13 kV lines accessible to customers, pole-mounted transformers are used to reduce the primary wire voltage of 13 kV down to the 240 and 120 volt levels required by electrical appliances in the home. The association between the location of the transformers and the vicinity of the birth homes of childhood leukemia victims proved to be statistically interesting, but the case was not as clear-cut as it may have seemed.

Although there appeared to be a correlation between the increased incidence of leukemia amongst young victims and the proximity of their homes to the transformers, a puzzling aspect of the distribution pattern of the relevant leukemia rates had also emerged which was inconsistent with this finding. In addition to the fact that the incidence of leukemia was significantly higher for those children living in houses closest to the pole-mounted transformers, a significant percentage of young leukemia victims had lived in **not** the first house away from the transformer, but the second house away. What was equally puzzling was that the leukemia rate fell sharply for children in the **third house** away from the transformer and was negligible in respect of the overall population for all the remaining houses on the line.[3]

Having consulted a physicist friend, Ed Leeper, about these unusual findings, it became clear to Wertheimer that there was a factor missing in her original equation about the direct and apparently straightforward relationship between the increased rate of leukemia in children and the distance of the transformers from the childhood homes of leukemia victims. The correlation could certainly not be explained in terms of the magnetic field generated by the transformer, nor by the alternating electric field generated by the transformer, nor by the alternating electric field generated by the wires as a result of the 60 hertz alternating current which passed through them on its path to households from the transformers. The reason for this is simply that the magnetic field given off by the transformer should in principle drop off so sharply that it would be negligible **even at the house closest to it**. Nor could the electric field generated by the alternating current in the lines be responsible for the **varying rates** of leukemia from one house to another, since the voltage upon which these fields would depend does not change in strength according to the wire distance from the transformers.[4] There would be no difference, in other words, in the force of the electric fields as manifest from one house to the other.

The key needed to unlock this final door in the investigation was found when Wertheimer enlisted Leeper's help for the production of a gaussmeter, a device used to measure magnetic field strengths. Testing the device in a neighbourhood whose pole and wire configuration were typical of the distribution network of the electricity system of the city, she was surprised by what she discovered. Beginning at the base of the transformer pole at an alley entrance, the gaussmeter gave off a loud hum, indicating the presence of a strong magnetic field. As she walked up the alley past the first house, however, the hum of the gaussmeter did not subside and strangely continued until she reached the next pole, located at the far corner of the lot of the second house where hum from the gaussmeter suddenly ceased. Wertheimer noticed that this was the point at which several wires known as 'service drops' linked up with and reduced the current load coming from the secondary distribution line fed by the transformer two houses away. She noticed also that the point at which the first-span secondary distribution line finished, coincided with the pronounced decrease in the childhood leukemia rate. On the basis of these initial observations Wertheimer postulated that the association she was searching for was **not** the proximity of the neighbourhood **transformer** to the homes of childhood leukemia victims, but rather the proximity of the **secondary distribution line** which ran from the transformer past the first two houses on the line to the service drop wires.[5] Since the secondary wire was carrying sufficient current to feed the dozen or so service lines directly supplying the local houses, it was producing the strong magnetic field which seemed to be implicated in the increased rate of childhood leukemia.



... follow-up studies revealed that the rate of leukemia for children living in dwellings where first-span secondary wires ran past them was disproportionately higher than for children living in homes away from these wires.

Wertheimer followed up her preliminary findings with an extensive investigation of the correlation between the field strengths of first-span secondary wires and the birth addresses of childhood leukemia victims. These follow-up studies revealed that the rate of leukemia for children living in dwellings where first-span secondary wires ran past them was disproportionately higher than for children living in homes away from these wires.[6] Encouraged by these findings, Wertheimer decided to expand her research to determine whether the incidence of other forms of childhood cancer could be associated with exposure to high-current wiring of any kind, not just first-span secondary wires.

Several categories of high-current exposures were identified and included in the study. Homes situated less than 50 feet from first-span secondaries, those within 65 feet of a group of three to five small-gauge primary wires, and homes located within 130 feet of either three-phase, large-gauge primary wires or of a group of six or more small-gauge primary wires, were all regarded as high-current risk homes.[7] The results of her research were startling and alarming. As Brodeur puts it:

> "During 1976 Wertheimer visited the birth and diagnoses addresses of each of the cancer cases, the birth addresses of each of the controls, and the addresses at which control children had been living at the time their matched cases had been diagnosed with cancer. She then proceeded to draw a diagram describing the location, size, type, and proximity of the electrical wires and transformers she had observed in the vicinity of each of these homes. Once that was done, she analysed the data and found that her prediction had held up: children who had lived in homes near high-current electrical wires had died of cancer at twice the rate seen in children living in dwellings near low-current wiring. The association was strongest among those children who had spent their entire lives in a high-current home. Particularly disturbing was the fact that of six children in the study population who had lived near high-current wires coming directly from power substations, all were cancer victims."[8]

Although it had previously been assumed that any harmful effects of electromagnetic fields would ordinarily be cancelled in household wiring, by virtue of the fact that return current tends to balance the supply current, Wertheimer and Leeper argued that such equilibrium is rarely preserved.[9] The problem is that some of the current which should return through the wires tends instead to flow through the ground. Inasmuch as most household electrical systems are grounded through the plumbing, the return current passes through the pipes of the house to produce a new magnetic field within the home itself. This suggestion was especially disturbing, since the duration of continuous exposure to a magnetic field

appears to be equally, if not more damaging to human health than the strength of the field in itself. This being so, exposure to a weak but constant magnetic field could be far more deleterious to human health than was at first supposed. Additional support for their hypothesis came to light in a US Public Health Service report which correlated the cause of death for men between the ages of twenty and sixty-five with their occupations.[10] According to Wertheimer and Leeper's analysis of this data, it was clear that the cancer rate for workers exposed to fairly regular exposures of alternating-current magnetic fields was significantly higher than for the overall population. Among some of the workers referred to were telephone and power linemen, subway and elevated-railway motormen, power station operators, electricians, and even welders.

When Wertheimer and Leeper's research was first published in 1979, their results were resoundingly rejected by the medical and scientific community which criticised the work as shoddy and poorly evidenced. The electric utilities industry quickly joined the ranks of orthodoxy to condemn the findings as heresy and the researchers as heretics.[11] Dismissed out of hand, it was not until 1986 that Savitz and his colleagues were one of the first research groups to announce that they had accumulated sufficient data to replicate and confirm Wertheimer and Leeper's conclusion that prolonged exposure to low-level magnetic fields generated by high-current wires significantly increased the risk of developing cancer in children.[12] According to Savitz's longitudinal study, the risk of developing any of the various types of childhood cancer is increased by more than five times the control population for those children living in homes in close proximity to high-current wires. It is important to note, by the way, that the Savitz study did not include any of the same cancer cases used in Wertheimer and Leeper's study and thus provides a genuinely independent measure of the magnitude of the problem.

Electric Razors and Electric Hair-driers

Once it was established that prolonged exposure to low-level electromagnetic radiation could increase the risk of cancer, Wertheimer turned her attention to household appliances in respect of which prolonged exposure is generally a characteristic of their use. The risk factors of relevance here need carefully to be distinguished, and the distinction should not be reduced simply to the difference between the health hazards associated with extremely low levels of electromagnetic radiation and those associated with extremely high levels. In addition to the question of individual hypersensitivity, the concept of dose-rate must be included in any risk-benefit ratio regarding the use of household appliances and electrical equipment.[13] The electric razor is a case in point. Electric current which is used for household appliances is, as we saw earlier, supplied at a frequency of 60 cycles per second (now known as 60 hertz). In basic terms this means that the current provided for our homes is an alternating current which flows first in one direction and then in the other, generating an electric field. When it does this at a frequency of 60 hertz, it is moving back and forth sixty times per second or generating a 60 hertz.

In the case of the electric razor the electromagnetic fields produced have been measured as 60 hertz fields with magnetic strengths as high as 200 to 400 milligauss one-half inch or approximately two centimetres away from the cutting edge of the blade. Since the blade is often in direct contact with the surface of the skin during the process of shaving, it is clear that the nearby tissues are being exposed to a powerful magnetic field. Since it has been established that 60 Hertz fields of as little as 3 milligauss are associated with an increased risk of cancer, the exposure levels from appliances such as electric razors, electric hair-driers, curling irons, etc., need to be carefully monitored.[14]

It is of course true that the electric razor is normally used for only a few minutes every day, and this brings in the point about the dose-rate as a factor in assessing the adverse impact on health of magnetic fields. It is generally assumed that if the dose-rate is low (exposure for only a short duration), the use of appliances which give off relatively high magnetic fields is safe. We have argued elsewhere that this assumption may not be as uncontentious as some researchers make it seem, but we do accept that the dose-rate is an important factor in any analysis of these matters. Let it be said, however, that neither of the authors makes use of an electric razor. The dose-rate for electric razors and other such high-strength-field appliances also varies considerably, so that a general statement about their safe use could be misleading. Although most women do not shave their legs every day, they do spend more time shaving their legs on any one occasion than do men shaving their faces on any one occasion. The fact that women have a higher incidence of melanoma on their lower legs than do men may be of relevance here. Some professions in which men are involved similarly require regular depilation, as in the case of professional body-builders, some dancers, some models and some competitive athletes such as cyclists and swimmers.

The dose-rate for hair-driers becomes equally variable. Both men and women tend to use an electric dryer to dry their hair at least once per day. The exposure time is generally longer than the dose-rate for the electric shaver, and the high-strength magnetic field generated is directed most often towards the skull and thus the brain. This brings into play another factor to which we have also alluded in previous NEXUS articles, namely, the extent to which certain parts of, or organs in, the body are more susceptible to toxic intervention (e.g., the accumulation of mercury or aluminium in the brain) or electromagnetic intervention (e.g., the special sensitivity of the reproductive organs to magnetic fields) than others. This issue has special import for those people working in occupations where certain vulnerable parts of the body are more directly exposed to magnetic field sources than others (e.g., women working at computer display terminals). In regard to the health risks of hair-driers, the much neglected example is the hairdressing profession in which the hair-drier is used frequently throughout the day. This being so, exposure of hairdressers to the relatively high electromagnetic fields generated by the professional hair-driers used in salons is not only regular, but the hair-drier is also frequently held in a position reasonably close to the breast, neck or head of the hairdresser as she or he blows dry the customer's hair. As far as the authors are aware, no study has yet been done of the potential health risks of electromagnetic radiation within this profession, though the questions which arise are of great interest.

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The Electric Blanket and the Heated Waterbed Connection

Although the field strengths of electric razors are, as we saw, relatively high, the daily exposure or dose is generally minimal. While this daily dependency upon an electrical device with strong field strengths is worrying, the worry pales in comparison with the potential health risks associated with the use of electric blankets and heated waterbeds. The field strengths of electric blankets are considerably lower than those associated with electric razors, ranging from 50-100 milligauss or about one-half to one-quarter the field strengths exhibited by razors.[15] The difference in the two cases is that the electric blanket is used for many hours at a time and is maintained as close to the total surface of the body as possible. This means that the accumulated exposure or total administered dose of electromagnetic radiation is considerably higher than the dose-level for the electric razor. The fact that the exposure is com-

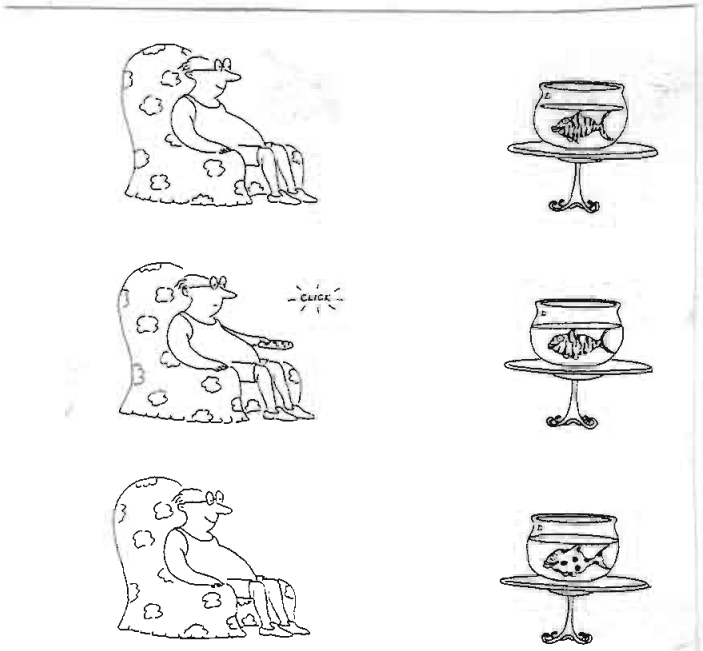
prehensive across the entire surface of the body also adds a new dimension to the question of dose impact, the health implications of which still need to be explored further.

Although the electric blanket generates a greater field strength than the heated waterbed, whose heating element is located on the underside of the bed, the heated waterbed produces a magnetic field reading of approximately five milligauss, the dose to which anyone lying in the bed would be exposed. Since the children involved in Wertheimer's earlier study on childhood leukemia were exposed to magnetic field strengths of only one to two milligauss, the potential health risks associated with heated waterbeds cannot go unattended. In respect of the dose-rate calculation, it is important to appreciate that while electric blankets are ordinarily used only during the coldest months of the year, heated waterbeds tend to be heated for longer periods than electric blankets.

They found that the incidence of miscarriage was disproportionately higher during the months in which these [waterbeds & electric blankets] were used than when they were not.

Why Electric Blankets Generate Magnetic Fields

The parallel wires in the middle of the electric blanket form an 'S' pattern through which the electric current flows. Because of the configuration of lines, the current flow through the 'S' pattern is balanced by the current flowing in the opposite direction, thus tending to cancel out or prevent the generation of magnetic fields. The heating element within the waterbed is similarly designed to minimise the generation of electric fields. The problem is that at the outer edges of both the electric blanket and the heated waterbed, the current becomes unbalanced. When this happens, the relatively significant electromagnetic fields characteristic of each appliance are generated.[16] Whether electric blankets and heated waterbeds could ever be constructed to avoid completely any current imbalance which might lead to the generation of a magnetic field strength of significance, is a moot engineering point. Suffice to say that to date we know of no brand of electric blanket or heated waterbed which can claim its product to be free of relatively strong electromagnetic fields.



The Health Hazards of Electric Blankets and Heated Waterbeds

Because of the problem of having to select a separate control population to establish whether those who used electric blankets or heated waterbeds have a higher incidence of cancer than those who do not, the research in the area has been designed instead to determine the effects of these electrical appliances on **foetal development**. This study is much simpler since it is possible to compare the effects of magnetic fields on the same population. For example, by comparing the rate of miscarriage during the winter versus the summer months for a single control population, it is possible to assess whether the use of electric blankets and heated waterbeds during the winter increases the rate of miscarriage during that period. Because the study deals with the same group of people, it is possible to eliminate the confounding influence of other factors such as a couple's dietary, smoking or drinking habits, thus isolating the role in miscarriage played by electromagnetic fields.[17]

Once again, it was the pioneering work of Wertheimer and Leeper which has served to advance the frontiers of knowledge in this area and encourage other researchers to continue their initial investigations.

Utilising a rigorously controlled experiment, Wertheimer and Leeper compared the rate of miscarriages among users of electric blankets and heated waterbeds as they occurred during the summer and winter months. They found that the incidence of miscarriage was disproportionately higher during the months in which these appliances were used than when they were not.[18] They discovered also that the rate of miscarriage was higher between September and the end of January. The greatest risk of miscarriage was thus observed to occur during the first months after conception and to coincide with the coldest period when the temperature setting of the appliances was likely to be set higher, thereby increasing the strength of the magnetic field generated.[19] No such seasonal pattern of miscarriage was reported among non-users. The results of their study also demonstrated a trend towards slower foetal development, and research is presently being done by Dr Michael Bracken of the Yale University School of Medicine to make more specific determinations regarding the patterns of growth and development of children exposed *in utero* to electromagnetic fields.[20]

In their first study on this matter published in *Bioelectromagnetics* in 1986, Wertheimer and Leeper admitted that the effects they had documented could also be interpreted as the effects of excessive heat exposure. In other words the increased rate of miscarriage, slower foetal development, and perhaps even some forms of childhood disability, might be due to the heat radiation generated by the appliances in question, rather than their electromagnetic fields. Excessive heat, for example, is known to have a deleterious effect on both sperm and ova.

In order to distinguish the different effects which each of these two factors might be playing in the increased risk of miscarriage, Wertheimer and Leeper undertook a new study in which the effect of electromagnetic radiation could be separated from the effects of heat radiation.[21] To do this they now focused their investigations on ceiling cable heating units, popular in many homes built during the 1960s and 1970s in the Eugene, Oregon area. They conceived of the ceiling cable units as a kind of big electric blanket in the ceiling. As in the case of the electric blanket, the current flowing along the edges of the ceiling cable pattern was also unbalanced, thus generating quite strong magnetic fields.[22] The difference was that while the human body would be exposed to the magnetic fields produced

by the ceiling cable, it would remain relatively unaffected by the heat radiation. The room would be warmed, in other words, without the body temperature being raised excessively.

With the new experimental situation well defined, Wertheimer now compared the seasonal rate of miscarriage for families living in homes heated by ceiling cable. As in the electric blanket study, the rate of greatest foetal loss was observed in the coldest months when the magnetic field strength generated by the cable was at its peak.[23] This variation in the seasonal pattern of spontaneous abortion was **not** manifest among families living in homes which relied on non-magnetic-field heating sources. On the basis of these results

Some appliances such as the electric razor generate considerable magnetic field strengths, but more research needs to be done to establish the acceptable dose exposure, if any.

Wertheimer and Leeper have re-affirmed their original hypothesis with confidence. Enough has certainly been said to show that it would be imprudent to ignore their conclusion. Given that exposure to the electromagnetic fields generated by electric blankets and heated waterbeds can significantly increase the incidence of miscarriage, these household appliances need to be used with caution, if at all. As the cost of home heating rises, the temptation is to make more rather than less use of electric heating devices designed to warm our beds. If the result of succumbing to this temptation is that the level of exposure to electromagnetic fields is increased, the temptation is best left resisted.

Other Hazards of Electric Blankets

It is clear that electric blankets are susceptible to leakage involving considerable current flow. This can be particularly dangerous in hospitals or in homes where electric blankets are used to heat the beds of patients with intercardiac connections, or otherwise plugged into electromedical equipment. Individuals with pacemakers are also vulnerable, as the electromagnetic field strengths of electric blankets are sufficiently high to cause pacemaker dysfunction. Microshocks can also result if electric blankets are used in conjunction with electromedical equipment, or if wires in the blanket are accidentally exposed or broken or even affected by wetness. Bed wetting, for example, can in certain circumstances of electric blanket use, prove to be extremely dangerous. This hazard of use provides a significant problem in the case of infants and the incontinent, as it also does for those who tend to perspire excessively or for some medical reason are prone to excessive drainage associated with a wound or surgical procedure. There is also the risk of hyperthermia burns from excessive heat due to faulty thermostatic controls or loss of skin sensation on the part of the patient. Electric blankets are not generally recommended for individuals prone to convulsions of fits and should be avoided in the case of unconscious or anaesthetised individuals.

What You Can Do To Avoid the Wrong Connection

It is clear that exposure to electromagnetic radiation in all of its forms needs carefully to be monitored. Some appliances such as the electric razor generate considerable magnetic field strengths, but more research needs to be done to establish the acceptable dose exposure, if any. The rule of thumb which we propose is, where there is a possible health risk and the return is not great, seek a minimal risk alternative. In the case of the electric razor, the safety razor is a relatively safe bet. If you feel you have to opt for the electric razor effect, try a battery-operated razor.

The electric blanket case deserves our special attention. In the light of current research on the magnetic field effects of electric blankets, the threat of increased risk of miscarriage should be a sufficient deterrent in respect of their use, at least for all pregnant women. Ordinary blankets provide a safe alternative, but if you feel you must use an electric blanket, there are ways in which you can minimise the risks. One helpful strategy is simply to heat the bed for an hour or so before retiring. Just before you are ready to go to bed, shut off the blanket and enjoy the warmth. Be careful not to switch the blanket off at the temperature regulator, or to assume that all is well simply because you have switched off the wall switch. A number of electric blankets are capable of generating a magnetic field if they are left plugged in at the wall socket. **Unplug** the electric blanket from the wall before actually getting into bed.[24] Similar precautions will make your use of the heated waterbed equally accommodating. Once you are in the waterbed, your own body heat, coupled with the heat from the bed water, will keep you surprisingly cosy and comfortable.

A few other helpful tips in minimising the risk of electric blanket use: Choose a blanket of the correct size so that wired areas of the blanket are never tucked in under the mattress. Do not use an electric blanket with a waterbed. If you use a waterproof sheet, cover the electric blanket with an ordinary blanket to absorb moisture below the waterproof sheet. When the blanket is switched on, never pile blankets or clothing on it. If you are not using the electric blanket, it is best to store it in a hanging position and unfolded. Never use pins to secure something to the blanket. Do not dry-clean electric blankets; if laundering is necessary, it is imperative to follow the instructions of the manufacturer. Keep the electrical leads and controls free of the bed at all times. Switch off the blanket whenever it is not in use. Check the blanket and the controls on a regular basis to ensure that neither has become faulty. Electric blankets should be replaced every two to five years, depending upon use. ∞

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